Environment, Energy, Security & Sustainability (E2S2)

Modeling Your Way Through EISA

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BUILDING STRONG®

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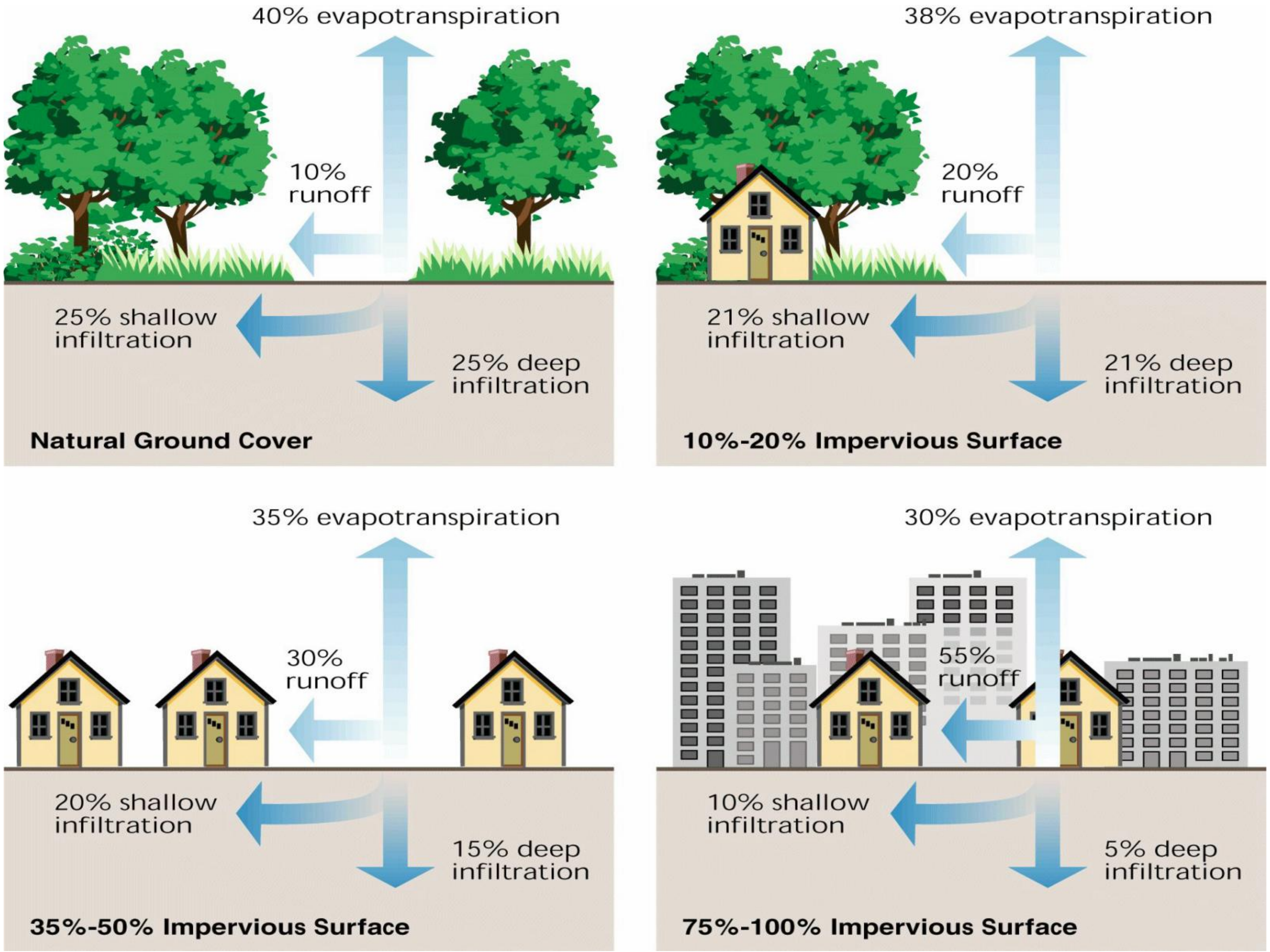
EISA Section 438

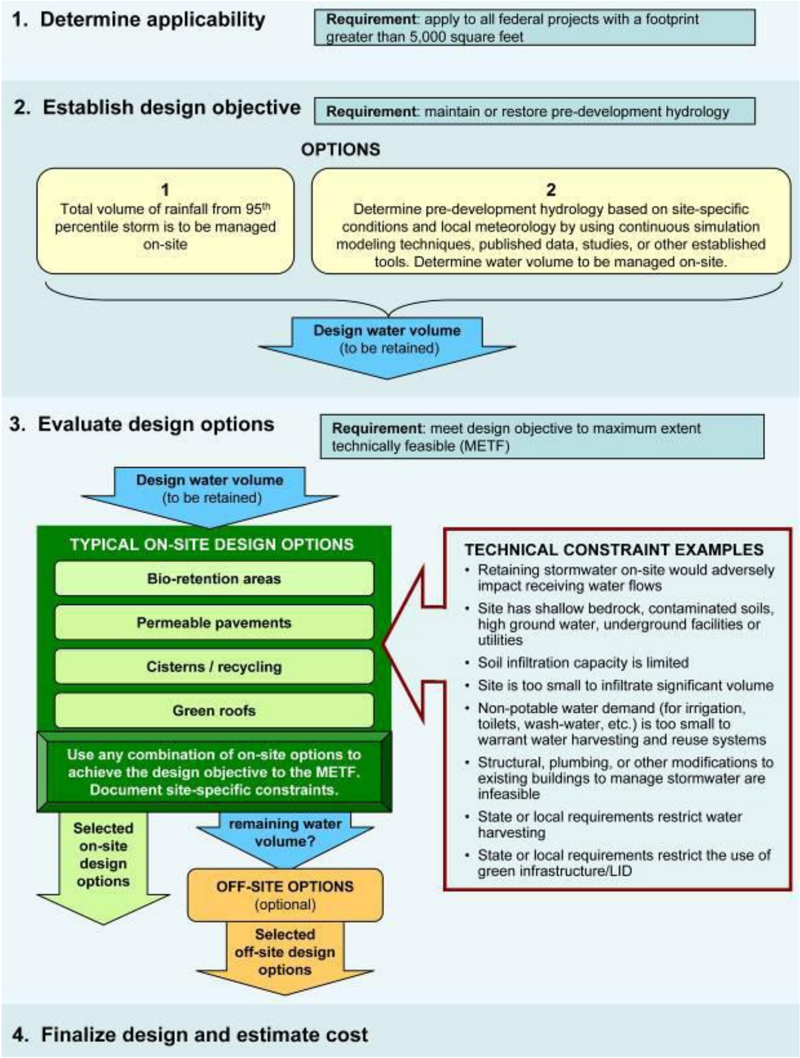
- Energy Independence and Security Act

"Storm water runoff requirements for federal development projects. The sponsor of any development or redevelopment project involving a Federal facility with a footprint that ***exceeds 5,000 square feet*** *shall use site planning, design, construction, and maintenance strategies for the property to* ***maintain or restore, to the maximum extent technically feasible, the predevelopment hydrology of the property with regard to the temperature, rate, volume, and duration of flow.****"*

Pre and Post-Development Hydrology (USDA)

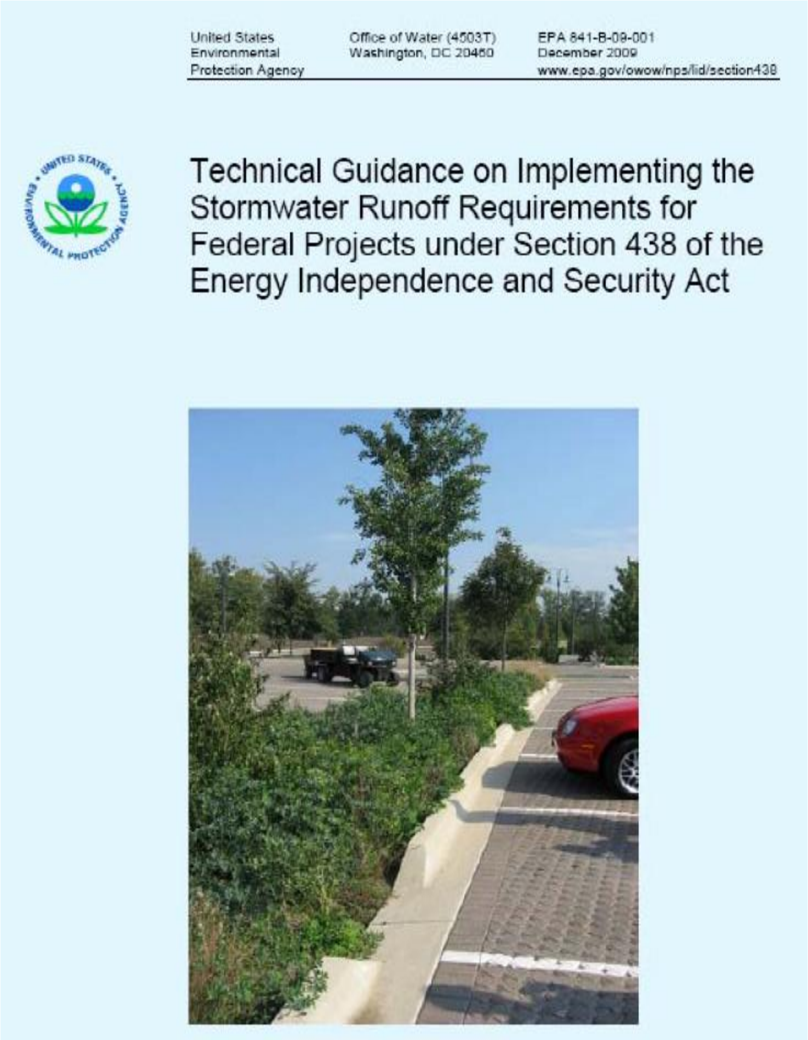


DOD EISA Flowchart



EPA Technical Guidance

EPA 841-B-09-001
December 2009
www.epa.gov/owow/nps/lid/section438


United States Environmental Protection Agency
Office of Water (4503T) Washington, DC 20460
EPA 841-B-09-001 December 2009 www.epa.gov/owow/nps/lid/section438

Technical Guidance on Implementing the Stormwater Runoff Requirements for Federal Projects under Section 438 of the Energy Independence and Security Act

Performance Design Objective

Option 1: Control 95th Percentile Rainfall Event (Flow = Precipitation x Area) or

Runoff = [(Precipitation * Impervious Area) + (Precipitation * Pervious Area)]/Total Area

1) Calculate or verify the precipitation amount from the 95^{th} percentile storm.
2) Employ onsite stormwater management controls to the maximum extent technically feasible (METF) that infiltrate, evapotranspire, or harvest and then use the appropriate design volume.

Option 2: Preserve predevelopment hydrology (rate, volume, duration & temperature)

1) Conduct hydrologic and hydraulic analyses.
2) Quantify post-construction hydrographs for the 1, 2, 10, 25, 50 and 100 year 24 hour storm events.
3) Maintain pre-development hydrographs for these storm events.

EISA Compliance Methodology

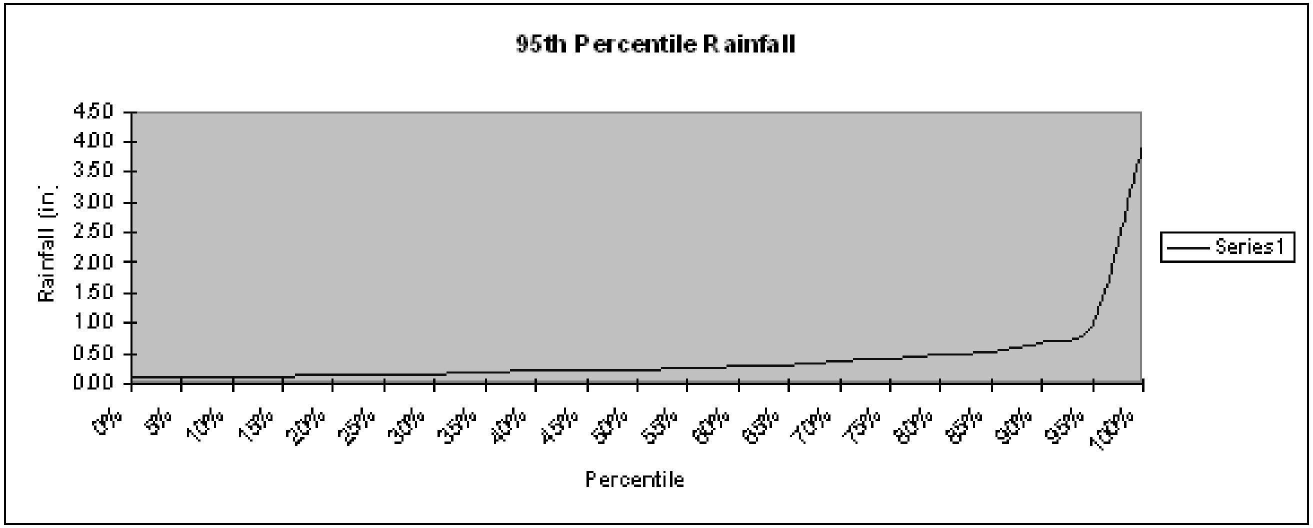
- Design objective is to maintain the pre-development hydrology
  - Pre-development conditions (temperature, rate, volume, and duration)
  - Design volume
- Use modeling or other recognized tools to establish objective
  - TR-55 curve number method is easy to apply and understand – a number of modeling systems employ this method.
- Evaluate design options (Low Impact Development/Projects) to meet objective to the maximum extent technically feasible (METF).
- Accountability
  - Site evaluation and soil analysis
  - Calculations for the 95th percentile rainfall event of the predevelopment runoff volumes
  - The site design and stormwater management practices (LID) employed on the site
  - Design calculations for each stormwater management practice
  - The respective volume of stormwater managed by each practice
  - Waiver, if applicable
- Complete a post construction analysis of features

Developing the 95th Percentile Storm (NAVFAC)

Rainfall (in)
0.10
0.10
0.10
0.10
0.10
0.10
0.10
0.10
0.10
0.10
0.10
0.10
0.10
0.10
0.10
0.11
0.11
0.11
0.11
0.11
0.11
0.11
0.11
0.11
0.11
0.11
0.11
0.11
0.11
0.11
0.12
0.12
0.12
0.12
0.12

Percentile	Rainfall (in)
0 %	0.10
5 %	0.10
10 %	0.11
15 %	0.12
20 %	0.14
25 %	0.15
30 %	0.16
35 %	0.19
40 %	0.21
45 %	0.22
50 %	0.24
55 %	0.26
60 %	0.29
65 %	0.31
70 %	0.37
75 %	0.42
80 %	0.48
85 %	0.53
90 %	0.69
95 %	0.98
100 %	3.98

95th Percentile Rain
P= 0.9835



1. Obtain 24-hr precipitation data set (NCDC)
   – http://www.ncdc.noaa.gov/oa/ncdc.html
2. Import into spreadsheet and aggregate into a single column
   – Eliminate storms with rainfall less than 0.1"
3. Calculate using PERCENTILE function or graphically

Example 95th Percentile Storms

City	95th Percentile Event Rainfall Total (in)	City	95th Percentile Event Rainfall Total (in)
Atlanta, GA	1.8	Kansas City, MO	1.7
Baltimore, MD	1.6	Knoxville, TN	1.5
Boston, MA	1.5	Louisville, KY	1.5
Buffalo, NY	1.1	Minneapolis, MN	1.4
Burlington, VT	1.1	New York, NY	1.7
Charleston, WV	1.2	Salt Lake City, UT	0.8
Coeur D'Alene, ID	0.7	Phoenix, AZ	1.0
Cincinnati, OH	1.5	Portland, OR	1.0
Columbus, OH	1.3	Seattle, WA	1.6
Concord, NH	1.3	Washington, DC	1.7
Denver, CO	1.1		

Low Impact Development Strategies

- Bioretention
- Soil Amendments
- Filter Strips
- Vegetated Buffers
- Grassed Swales
- Dry Wells
- Infiltration Basins/Trenches
- Inlet Pollution Removal Devices
- Rainwater Harvesting (Rain Barrels and Cisterns)
- Tree Box Filters
- Vegetated Roofs
- Permeable Pavers

Potential Methods for Analyzing Control Measures

Model Considerations		Rational Method	TR-55	SWMM	Direct Determination	HSPF	QUALHYMO
Temporal Scale	Single Event	Yes	Yes	Yes	Yes	Yes	Yes
	Continuous Simulation	No	No	Yes	Possible	Yes	Yes
Spatial Scale	Lot-level	Yes	Yes	Yes	Yes	No	No
	Neighborhood	Yes	Yes	Yes	Yes	Possible	Possible
	Regional	Yes	Yes	Yes	No	Yes	Yes
Outputs	Peak Discharge	Yes	Yes	Yes	No	Yes	Yes
	Runoff Volume	Yes	Yes	Yes	Yes	Yes	Yes
	Hydrograph	Yes	Yes	Yes	No	Yes	Yes
	Water Quality	No	No	Yes	Possible	Yes	Yes

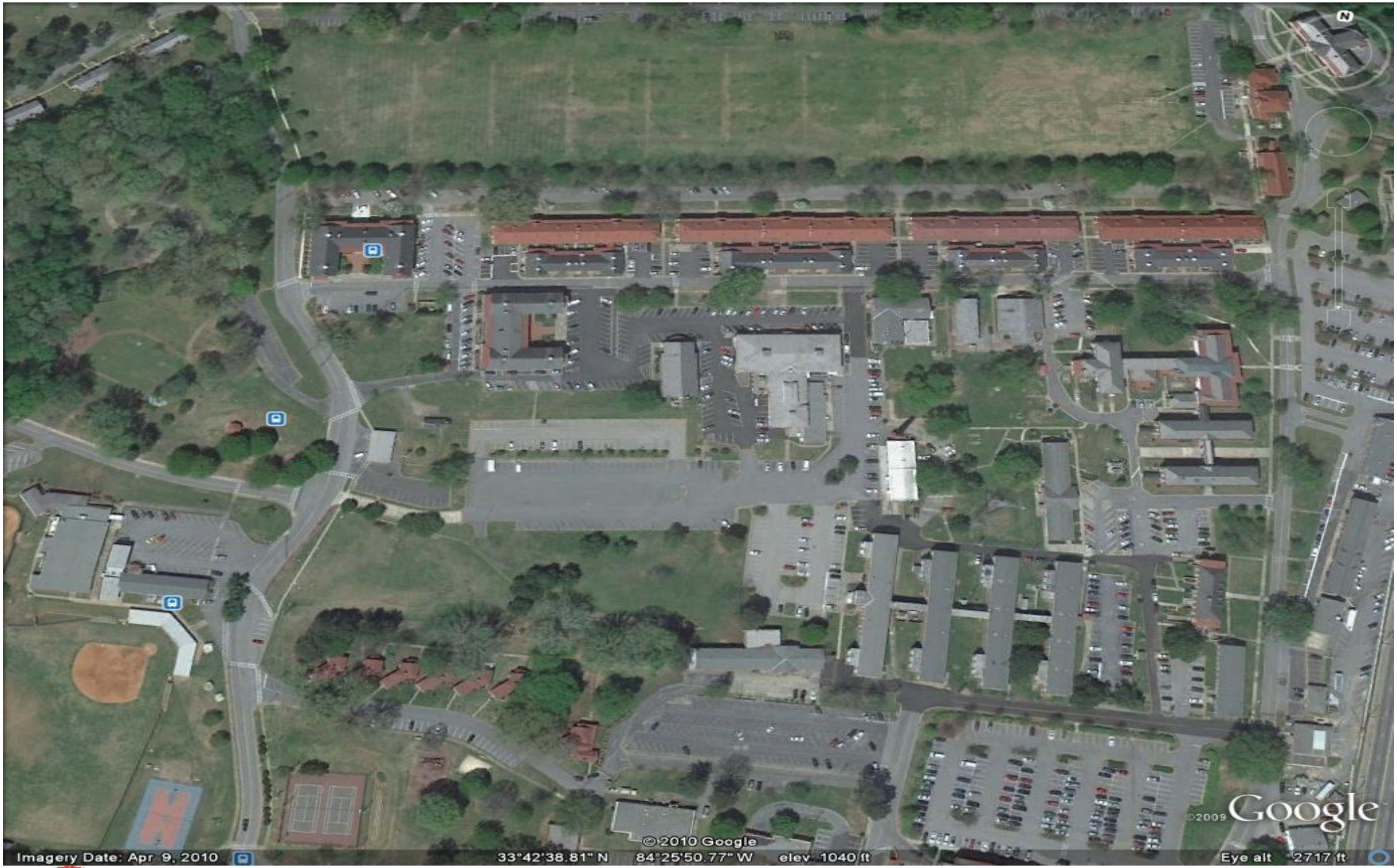
Comparison of Approaches

Method	Strengths	Weaknesses
Direct Determination	• Methodology (Manning's Eq.) for runoff determination is same as SWMM • Models basic hydrologic processes directly (explicit) • Simple spreadsheet can be used	• Direct application of Horton's method may estimate higher infiltration loss, especially at the beginning of a storm • Does not consider flow routing
Rational Method	• Method is widely used • Simple to use and understand	• Cannot directly model storage-oriented onsite control measures
TR-55	• Method is widely used • Simple to use and understand	• May not be appropriate for estimating runoff from small storm events because depression storage is not well accounted for
SWMM	• Method is widely used • Can provide complete hydrologic and water quality process dynamics in stormwater analysis	• Needs a number of site-specific modeling parameters • Generally requires more extensive experience and modeling skills

Comparison of Approaches

Attribute	Models				
	HSPF	SWMM	TR-55/TR-20	HEC-HMS	Rational Method
Sponsoring agency	U.S. EPA	U.S. EPA	NRCS	USACE	N/A
Simulation type	Continuous	Continuous	Single Event	Continuous	Single Event
Water Quality analysis	Yes	Yes	None	Under Dev.	None
Rainfall/Runoff analysis	Yes	Yes	Yes	Yes	Yes
Sewer system flow routing	None	Yes	Yes	Yes	None
Dynamic flow routing equations	None	Yes	Yes	None	None
Regulators, overflow structures	None	Yes	None	None	None
Storage analysis	Yes	Yes	Yes	Yes	Possible*
Treatment analysis	Yes	Yes	None	None	None
Data and personnel requirements	High	High	Medium	Medium	Low
Overall model complexity	High	High	Low	High	Low
* = If one assumes a triangular runoff distribution then the Rational Method can be used to compute storage.					

Fort McPherson, Atlanta, GA



Providing Solutions to Tomorrow's Environmental Problems

LID Runoff Curve Number

- TR-55 model
- LID implementation alters the on site infiltration capacity
- Factors to consider
  - Land Cover Type
  - Percent of Imperviousness
  - Hydrologic Soils Group
  - Hydrologic Condition
  - Disconnectivity of Impervious Area
  - Storage and Infiltration

Impact of LID Techniques

Suggested Options Affecting Curve Number (CN)	Limit use of sidewalks	Reduce road length and width	Reduce driveway length and width	Conserve natural resources and areas	Minimize disturbance	Preserve infiltratable soils	Preserve natural depression areas	Use transition zones	Use vegetated swales	Preserve vegetation
Land Cover Type				✔	✔			✔	✔	✔
Percent of Imperviousness	✔	✔	✔					✔		
Hydrologic Soils Group				✔		✔				
Hydrologic Condition				✔	✔	✔				
Disconnectivity of Impervious Area	✔	✔	✔							
Storage and Infiltration							✔			✔

Source: Prince George's County, MD, 1999

LID Techniques to Maintain Onsite Hydrology

	Low Impact Development Technique									
Low Impact Development Objective	On-lot bioretention	Wider and flatter swales	Maintain sheet flow	Clusters of trees and shrubs in flow path	Provide tree conservation/ transition zones	Minimize storm drain pipes	Disconnect impervious areas	Save trees	Preserve existing topography	LID drainage and infiltration zones
Minimize disturbance	✔		✔	✔	✔	✔	✔	✔	✔	
Flatten grades		✔	✔			✔			✔	✔
Reduce height of slopes						✔			✔	✔
Increase flow path (divert and redirect)		✔	✔	✔		✔	✔	✔		
Increase roughness "n"	✔		✔	✔	✔	✔	✔	✔		✔

Source: Prince George's County, MD, 1999

TR 55 Curve Numbers

Cover description		Curve numbers for hydrologic soil group			
Cover type and hydrologic condition	Average percent impervious area [2]	A	B	C	D
Fully developed urban areas (vegetation established)					
Open space (lawns, parks, golf courses, cemeteries, etc.) [3]:					
Poor condition (grass cover < 50%)		68	79	86	89
Fair condition (grass cover 50% to 75%)		49	69	79	84
Good condition (grass cover > 75%)		39	61	74	80
Impervious areas:					
Paved parking lots, roofs, driveways, etc. (excluding right-of-way)		98	98	98	98
Streets and roads:					
Paved; curbs and storm sewers (excluding right-of-way)		98	98	98	98
Paved; open ditches (including right-of-way)		83	89	92	93
Gravel (including right-of-way)		76	85	89	91
Dirt (including right-of-way)		72	82	87	89
Western desert urban areas:					
Natural desert landscaping (pervious areas only) [4]		63	77	85	88
Artificial desert landscaping (impervious weed barrier, desert shrub with 1- to 2-inch sand or gravel mulch and basin borders)		96	96	96	96
Urban districts:					
Commercial and business	85	89	92	94	95
Industrial	72	81	88	91	93
Residential districts by average lot size:					
1/8 acre or less (town houses)	65	77	85	90	92
1/4 acre	38	61	75	83	87
1/3 acre	30	57	72	81	86
1/2 acre	25	54	70	80	85
1 acre	20	51	68	79	84
2 acres	12	46	65	77	82
Developing urban areas					
Newly graded areas (pervious areas only, no vegetation) [5]		77	86	91	94
Idle lands (CN's are determined using cover types similar to those in table 2-2c).					

1 Average runoff condition, and $I_a = 0.2S$.

2 The average percent impervious area shown was used to develop the composite CN's. Other assumptions are as follows: impervious areas are directly connected to the drainage system, impervious areas have a CN of 98, and pervious areas are considered equivalent to open space in good hydrologic condition. CN's for other combinations of conditions may be computed using figure 2-3 or 2-4.

3 CN's shown are equivalent to those of pasture. Composite CN's may be computed for other combinations of open space cover type.

4 Composite CN's for natural desert landscaping should be computed using figures 2-3 or 2-4 based on the impervious area percentage (CN = 98) and the pervious area CN. The pervious area CN's are assumed equivalent to desert shrub in poor hydrologic condition.

5 Composite CN's to use for the design of temporary measures during grading and construction should be computed using figure 2-3 or 2-4 based on the degree of development (impervious area percentage) and the CN's for the newly graded pervious areas.

Hydrologic Soil Groups

Group B - Soils in this group have moderately low runoff potential when thoroughly wet. Water transmission through the soil is unimpeded. Group B soils typically have between 10 percent and 20 percent clay and 50 percent to 90 percent sand and have loamy sand or sandy loam textures. Some soils having loam, silt loam, silt, or sandy clay loam textures may be placed in this group if they are well aggregated, of low bulk density, or contain greater than 35 percent rock fragments.

Group C - Soils in this group have moderately high runoff potential when thoroughly wet. Water transmission through the soil is somewhat restricted. Group C soils typically have between 20 percent and 40 percent clay and less than 50 percent sand and have loam, silt loam, sandy clay loam, clay loam, and silty clay loam textures. Some soils having clay, silty clay, or sandy clay textures may be placed in this group if they are well aggregated, of low bulk density, or contain greater than 35 percent rock fragments.

Fort McPherson, Atlanta, GA

Fort McPherson Example

A 21-acre site with 70% impervious area was selected in Atlanta, Georgia.

If the 95th percentile rainfall event (1.77 inches) occurred on the existing site (i.e., with no control measures), 1.17 inches of runoff would be generated and require management.

The runoff from the 95th percentile rainfall event could not be adequately retained solely with bioretention systems.

Based on the technical considerations of constructing and maintaining control measures at the site, it was assumed that up to 15% of the pervious area could be converted into bioretention cells and up to 40% of paved area could be converted into a paver block system.

If the stormwater management techniques used on the site includes both bioretention and paver blocks, then all runoff for the 95th percentile rainfall event would be controlled.

Example – Fort McPherson

Total Area (acres)		21	
Estimated Imperviousness (%)		70%	
95th Percentile Rainfall Event (inches)		1.77	
Expected Runoff for the 95th Percentile Rainfall Event (inches)		1.17	
Stormwater Management Area Required		Hydrologic Soil Group	
		B	C
Bioretention estimated by the Direct Determination (acres)		0.9	
Paver block area estimated by the Direct Determination (acres)		0.9	3.2*
Bioretention estimated by TR-55		0.8**	0.9
Paver block area estimated by TR-55		0**	1.84
Off-site storage necessary to control 10-yr event of 6.0 inches (acre-ft)	With onsite controls	5.85	6.62
	Without onsite controls	7.25	8.49

*The size of porous pavement was increased because the bioretention already reached its maximum size based on the site-specific design assumptions.

**Because TR-55 estimated smaller runoff in this scenario, bioretention can retain all of the 95th percentile runoff if the site has soil group B.

Summary

- Implementation of Section 438 of the EISA can be achieved by incorporation of GI/LID
- EPA 841-B-09-001 provides technical guidance on implementing the stormwater runoff requirements
- Several models are available to support stormwater modeling analysis efforts
- Defensible and consistent hydrologic assessment tools should be used and documented

Questions